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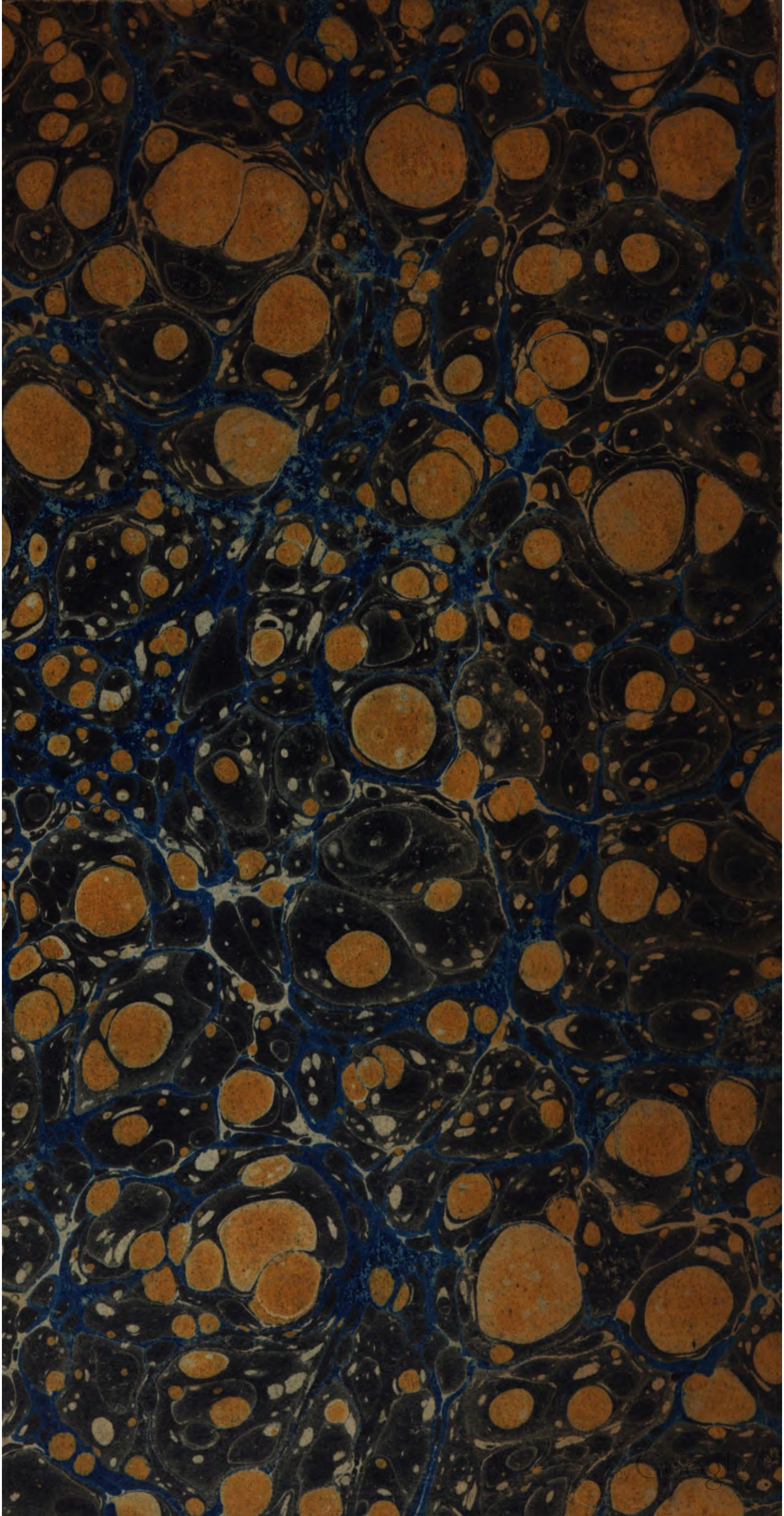

47. 832.

A NEW
THEORY OF THE TIDES:

IN WHICH
THE ERRORS OF THE USUAL THEORY
ARE DEMONSTRATED;

AND PROOF SHEWN
THAT
THE FULL MOON IS NOT THE CAUSE
OF A
CONCOMITANT SPRING TIDE,
BUT
ACTUALLY THE CAUSE OF THE NEAPS.

TOGETHER WITH
REMARKS AND OBSERVATIONS
USEFUL TO
ALL WHO NAVIGATE THE OCEAN.

Second Edition, carefully revised, with many Additions by the Author,
JOHN DEBENHAM, COMMR. R.N.

"The works of the Lord are great, sought out of all them that have pleasure therein."—PSALM cxi. 2.

[Entered at Stationers' Hall.]

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DOMI NUS ILLU MINA TIO MEA

NOTICE.

TO THE READER.

The Critic Writer in that usually respectable periodical, 'The Athenæum,' in the number for January the 16th, last, having, under pretence of writing a criticism on this tract, 'A new Theory of the Tides,' &c. to which the Editor has given insertion; and having, instead of any way touching the matter, the subject of the tract, condescended so low as to make, of what ought to be a calm philosophical disquisition, a very violent personal attack upon its Author; because he rebuked Men of Science, for involving in obscure and unexplained terms, the solutions they pretend to give, of mathematical questions; and because he has written, in taking leave of his reader—whom he styles lector benevolus, *kind reader—benevolus!* instead of writing, as the Critic says Virgil would have done, *benevole*, (which may however bear a question.) On this account it is deemed obligatory on the Author to repel, as best he can, this rancourous, but quite irrelevant attack; and to shew that the Critic, with all the hostility possible, has not been able to impeach the theory itself, or any part thereof; and that the intended reproach, since it touches not at all the matter, may be considered as its highest compliment, and amounts to an entire corroboration and admission of its claim to be what the title page announces.

The entire criticism, with a letter to its author in reply, is given, so that the reader may judge for himself; and because, instead of refuting, it corroborates the Theory, it is hoped that its introduction will be considered quite proper, and will have the effect of removing from it a character of mere personality.

The criticism is as follows:

" *A New Theory of the Tides, by Commander John Debenham, R.N.*—Not a new
" theory by any means: there never was a beginner yet who was not troubled for a
" few minutes with the palpable misconception which Capt. Debenham erects into
" a new theory. The plain truth of the matter is, that the worthy Officer, hearing
" that tides are caused by the attraction of the Sun and Moon, puts the whole forces
" of those planets" (but, N.B. the Sun is no planet, Mr. Critic,) " to work upon the
" water. A tyro's knowledge tells him, that it is the difference between the actions
" upon the water and upon the solid parts which is the producing cause of the
" phenomenon. Hence our author gets puzzled at the Moon producing a tide on
" both sides of the Earth;" (not puzzled, Sir; for the proposition, as you put it,
is denied:) " and there being spring tides when the Sun and Moon are on opposite
" sides of the Earth, &c. He begins by complaining of mathematicians using Greek
" letters with little or no condescending explanation as to their value. We saw
" many years ago, in a Public Journal, an attack on the tides investigations then
" commencing—combined with a charge of pedantry against mathematicians for
" using Greek letters. Surely this must have been written by Captain (then perhaps
" Lieutenant) Debenham. To shew, however, that this complaint is for others,
" and not for himself, the author, in the present case, exhibits his acquaintance
" with the Greek alphabet, by telling us that much of science" (say pretended
science) " is φυλγε, and that the professors keep what knowledge they have to
" themselves. Beyond a doubt, if such were their intention, they have succeeded
" so far as he is concerned. He also quotes Virgil thus—'Hic labor hoc opus est.
" Ahem! ahem! Virgil.' But he ends with 'Tamque lector benevolentia vale!'
" This is amended in manuscript, (by himself, we presume,) in the copy forwarded
" to us into *benevolus*. To which we say, ahem! ahem! *not* Virgil. Virgil would
" have written *benevole*. We often say more of speculators than some of our readers
" think necessary—because we know that ignorance with assurance is power, as
" well as knowledge. Sometimes we feel pain in writing down, a well intentior

"and earnest person, though wrong headed withal, by the name which Dogberry "yearned for:" (No, pseudo Criticus, Dogberry did not yearn for any such appellative as that to which you allude, but on the contrary, was highly indignant at the compellation; and you appear as little to understand Shakspeare, as Virgil or Ovid:) "but we have no compunction in the present instance. We never saw a more "decided combination of all the qualities to which it is difficult to be a benevolent "reader."

To the above Criticism, and to its Author, the following is the reply made by the Writer of this Tract.

To the Author of the pretended Criticism on a Tract called 'A New Theory of the Tides,' &c. &c. by John Debenham, Commander R.N.

Sir, Chelsea, March 22, 1847.

It is only within these few days that I have heard of your having condescended to notice the above tract, which I find you have done in the Athenæum for January, the 16th ultimo; and on obtaining your publication, I find you endeavour to promulgate opinions, alike derogatory both to the tract and its author. The man of Uz (did you ever hear of him?) emphatically exclaims, "Oh—that mine adversary had written a book!" (of censure of course, and the more malignant the better;) surely I would take it upon my shoulder, and bind it as a crown to me!—that satisfaction, thanks to your endeavour to injure, you have given me to possess. As, however, it appears something doubtful if ever you have properly read the tract, and may have lost your copy, I take leave to request your acceptance of another, sent herewith; by which you will see that when I censure literary men for involving their pretended solutions of mathematical questions in ambiguity, and in characters of the Greek alphabet, without giving any intimation of the value to be attached to these symbols—that I consider such conduct on their part to be rank quackery; if they mean not to mystify, but to instruct; surely you will not undertake to say that the practice is at all ingenuous, and hence it comes within the category of that superabundant article which every where we meet with: (do you, good Sir, deal in it? and is not your entire criticism formed of no other than that contemptible staple?)—the name of which, in the vernacular, is fudge! And in the tract I put the word in Greek characters to pay the Mystagogues in their own coin, and thus endeavour to shame them out of such unbecoming affectation; and I grieve to think that your obtusity has prevented your perception of this small morsel of racy humour, or that the dulness of your over satiated taste prevented your enjoying it; which if you belong to the genus *risibile*, you ought to have done. And as to my not understanding the conflicting theories of these learned men, you will see that I do understand, have given an account of, and have refuted them all; at least all the principal, not excepting that of the learned and medalated Professor of Cambridge; and it ought to be known that the ignorant recommendations of some of them have produced useless national expence, and the outfitting of expeditions alike foolish in their conception and fatal in their result:—that to the Niger, for example; and a contemplated expedition to be made in air balloons, to investigate the ever changing state of atmospheric phenomena. We may well say with Felix, Saul! Saul! "much learning," &c. I have not only refuted, but shewn alike their insufficiency and absurdity, and that they are not even plausible; and your criticism has made it quite apparent, that though you intimate a disposition to defend, you do not so much as understand them yourself.

But this my censure of the learned Mystagogues, and attempt at wit at their expense, has nothing whatever to do with the gist of the tract, and is quite irrelevant to the subject to be considered, and which you appear to be incapable of touching, otherwise you would not have slovened over the matter as you have done.

But with a view to an attempt at enlightening you *a little*, as to what the tract expresses and proves at large, the matter at issue is this: it having been shewn that the influence of the Moon *alone*, is not capable of producing a spring tide; much less when her influence is counteracted by that of the Sun, as it is at the time when she is at full; but that the united force of the Sun and Moon's attraction, exerted upon the waters at time of new Moon, can and does produce the above phœnomenon. Hence we have an efficient cause, and it is contrary to all philosophy when having found one clearly efficient cause, to seek for another. To the new Moon, joined with the Sun, we therefore ascribe the cause of the spring tides; and to the full Moon, whose attractive influence is then diminished by the counteracting power of that issuing from the Sun, that of the neaps; and that there is no such thing as a vapourous hem! Shakspeare! or yet aqueous drop profound! hanging down or rising up at opposite meridians—as fondly imagined, and rushing along with the astounding velocity of 1300 miles an hour, which it must do, if it ascends the Atlantic, and that with an increase of velocity as it mounts upwards towards the north. How could the wise men imagine such a thing? On the contrary, it is demonstrated that the celestial influences, in conjunction with the resistance offered by the Polar ice and the approximating Continents, have established a succession of undulatory motions in the waters—which reciprocally advance and repel each other: the advancing wave constituting the flood, and the repulsed wave the ebb; obeying the direction of the channel, or strait, or sea—between the banks of which (barring obstructions) the undulum has to proceed, and that at a rate, variable according to circumstances, of about 60 miles an hour on the open sea. So that at about every 720 miles distance, there will be found in the direction of the undulæ, simultaneous high—or low—or any other condition of the waters, at or about every twelve hours interval: thus accounting for the ebb as well as the flood. Whereas your theorists make the whole body of the waters to proceed continually onwards in the same direction. And it is demanded, in what other publication than this, do you find such a theory as the above, or any thing like it?

These are the points, *O' crate, pig, magnanimous critic,* (hem! Shakspeare!) to the refutation of which your acumen, not venom, *no, by no means,* should have been directed; nor should you have rested satisfied with shewing that I did not know how to write Virgilian latin as well as yourself; the only point of criticism you attempt to approach!

And you commence by saying that the Theory is "*not new, by any means;*" and you intimate an opinion that I have written much about the same thing many years ago; which if I have done, O most logical Sir, would it not fully vindicate the appellation I give it, '*A New Theory,*' *&c.* and also establish for me the claim to its paternity? *But which I have not done;* and therefore I again require you to inform me in what particular publication it may be found, or otherwise I shall feel at liberty to consider you as labouring under some confusion of ideas and to be mistaken.

And although the matter should be otherwise, if the theory be good, its having been formerly promulgated is no disparagement to it; that which we now receive as the Copernican or Newtonian System of the Universe, is stated to have been known to, and taught by Pythagoras.

It is hard to conceive the hallucination under which you must have laboured when you thought that when I quote from Virgil, "Hic labor, hoc opus est," and subjoin, from the Farce in which Dr. Pangloss figures with so rich a vein of homour, his "ahem! ahem!"—that I meant to be understood as though Virgil had uttered that exclamation; but you did so ineptly understand me; because a little lower down you produce another ahem! which you declare to be your own, and not Virgil's. My ahem! was intended to excite a smile from its association with the character of the above learned and grotesque personage, and thereby break the tedium and relieve the monotory of a long chain of argument, and of operose deductions; and it would seem as though you had forgotten the passage of the bard, illustrative of the difficulty of bringing to a happy conclusion, a hazardous undertaking; wherein having introduced the descent by Æneas into hell, and his return, he says, "Facilis est descensus in Avernum," &c.; but safely to return, "Hic labor, hoc opus est." And as the result of my investigation was dubious at its commencement, and was prosecuted at intervals through a length of years; on its being finally brought to a happy conclusion, I have a right to say from Virgil, "Hic labor! hoc opus est!" And when next you pretend to quote an author, with a view to giving him a good scalping, you had better put on your spectacles, and see that you quote him correctly; that you do not misquote him, and thereby exhibit *yourself*, in the character of the rudent, long eared, shoulder striped animal, to which you delight to allude, and laden with malice withal. I did not write *Tamque*—which, as you have placed it, is nonsense, and being your own, do pray take it back. What I wrote is *Jamque;* "Jamque opus exegi," &c. What, Sir! are you a professed critic, and have you forgotten your Ovid also, as well as misapprehended Shakspeare? I had quoted the words before, with the addition of 'hush! hush! no more of that,' meaning, besides provoking a smile, to say, that having brought my labour to a happy termination, I had a right to boast a little,—though not to the extent of Ovid, whose boasting, though very high swollen, has turned out to be literally verified; the passage is so beautiful, that like a facinating air, it may well bear repetition, even though there may be no occasion.

But, in plain truth, to my apprehension, as well as to that of sundry others, this tract,—*I say my new theory,*—is the only probable and rational account of the mystery of the tides, that ever has been written, and the arguments by which it is supported, so far as you are concerned, quite irrefragable. For you do not so much as attempt to refute my statement of any material fact, or to overthrow any argument thereon founded. Still less do you presume to impeach the earnest appeal I make to Seamen, and the advice I give them, with a view to excite their vigilance; the want of which has in so many instances proved fatal. And with this intent chiefly the tract was written; and this consideration ought to have been for me, a redeeming point, even though it may be otherwise ever so absurd. For, as to this or that theory, considered by itself, I care nothing for any of them; let the tides (as they will) ebb and flow as usual; but as a practised old Seaman, I lay it very much to heart, to hear of vessels being perpetually lost through want of care, combined with the ineptitude of the persons in charge. And as ignorance of the to be expected set and velocity of tides has much to do with this important matter; to put them on their guard, and to give them sound advice, I wrote the tract; which I consider, Tamquam oblatunculæ Deo, pro causa nautorum. Find fault with that latin, if you please; but as to the sentiment, it is to be feared you are incapable of appreciating it. I get nothing, I hope for nothing from the tract; I expect nothing but reproach for publishing it, as stated in its opening; and of which article you have endeavoured to supply me with a rare sample. And as to the theory itself, though quite simple, it appears to be (as has been said) far above your comprehension.

Instead of demonstrating its impossibility,—or of my suppositions being founded in reason, and most probably in fact,—and shewing that my conclusions are not legitimately deduced from the premises,—you inform the public that I have written false latin; having written *benevolus* where Virgil would have written *benevole;* and on this account, according to your candour, I am *an Ass!* Yes, a presumptuous. ignorant ass! So let it be. What has that to do with the question, beyond the exhibition of your own splenetic ignorance?—has been before and is again demanded. And though my latin might have been ever so proper, it would seem as though you were incapable of reading it:—vide 'tamque,' for instance.

But, O! Aristarchus! Aristarchus! how, on so slender an occasion, could you have been so bitter?—So coarse, so great, so little an Aristarchus! And O! Criticus Malevolus!—*since you will have it so:*—with great respect, to your careful reflection, all the above is offered.

To my tract—your criticism, and this my reply, will form an appropriate introduction.

Thus it is that I take your observations in the best possible part—take them upon my shoulder, bind them to me as a crown—for you have said against the tract every thing which your *acknowledged ill will* enables you to say, and as the whole amounts, to mere nothing—it is tantamount to its full vindication, and is highly complimentary, and far more valuable than any fulsome studied harangue in its praise from you would have been. And permit me to add, that if the contents of this tract had been known and acted upon by the persons in charge, none of the late fatal steam boat catastrophes would have occurred; and if you had possessed the least grain or spark of candour, you would have, instead of saying that I conclude with *tamque, &c.*, looked on, over the three following pages, wherein you would have seen—that what I suggest as the theory, is fully corroborated by authentic calculations and indubitable authorities. And also, you would have found a hard mathematical sort of a cob-nut, in the cracking of which to exercise your critical and scientific jaws! A question, on the solution of which, neither *blatherum* or yet Virgilian latin will avail so much as a jot.

Vale.
Health and happiness attend you,
JOHN DEBENHAM.

"'Tis thus the Bee, with sense how subtilely true!
"From poisonous weeds extracts the healing dew."
Ahem! Pope.

And in thus attempting to gibbet me,—you have been so mal adroit as to slip the plank from under your own feet, and the noose having caught you by the neck—there you are, suspended, an object at which the finger of scorn will continually point.

Like Haman, thus! th' unjust Critic see!
In his own snare; bound up to his own tree!

THE Author of the following pages having deceased before the complete printing of this edition, it is deemed a small tribute due to his memory to say, that he commenced and finished the work as it now stands, with no other intent than as a *little offering to God in the cause of Sailors;* and that, however it may please the Critic to cavil at the style in which it is written, the good advice and sound reasoning therein contained, are in no wise injured or refuted; even allowing the Latin quotations to be incorrect, he never intended or wished to be thought an accomplished writer; criticisms on this point, therefore, are quite uncalled for, and beside the question. It also appears most extraordinary that the *kind* Critic of the Athenæum should find fault with the word *benevolus*, which is really no fault, as it may be in the nominative or vocative case, and pass unnoticed other and glaring errors in the same phrase, in the first edition, without in the least attempting to refute or stultify the Theory itself.

F. D.

A
NEW THEORY.

Nearly two thousand years have now elapsed since the Mantuan swain, in numbers of a sublimity and sweetness peculiarly his own, expressed his desires—

> "———The ways of wandering Stars to know,
> The depths of Heaven above, and Earth below,
> To know the various labours of the Moon,
> And whence proceed the Eclipses of the Sun;
> Why flowing tides prevail upon the main,
> Into what dark recess they sink again!
> What shakes the solid Earth; what cause delays
> The Summer nights, and shortens Winter's days."
>
> GEORGIC II.

And though discoveries, chiefly modern, have enabled even our gyneacea, to account for and explain the cause of most of these phœnomena, the subject of the Tides has not been so happily expounded as the other above alluded to, wonderful operations of nature; for, with the exception of the grand discovery of Newton—a name far transcending that of Maro—that the cause of the Tides is attributable to the influence of the attractive forces of the heavenly bodies, chiefly to those of the Sun and Moon, little up to this time has been properly explained; on the contrary, absurdities and anomalies have been introduced into what, by learned men and professed philosophers, have been offered as solutions of this difficult question. And there having lately risen up an awakened interest towards the subject, and also a set of experiments and observations set on foot for the purpose of its elucidation; but which, though both expensive and troublesome, can by no possibility throw the smallest light on the mystery, or be attended with the least practical utility; and very particularly, as those who undertake to expound their discoveries to such as may be desirous of information, instead of clothing their ideas in intelligible language, involve themselves in the mystery of an abbreviated algebra, in which for symbols they make use of the Greek characters, with little or no condescending explanation as to their value. From whence it may be inferred, that if the Professors are masters of any knowledge, they are determined to keep it to themselves; the which conduct seems to bring to mind Tully's observation about the Augurs in the forum, and to engender a suspicion that much of what is exhibited in many departments of Science, in the vernacular, is mere *φυδγε*.

On this account, and because the Author of this Tract is of opinion that he has something both new and profitable to offer on the subject, and has therefore a right to hope for a candid interpretation, ***if such be possible.*** The poet says it is not;

> "Truth would you teach, or save a sinking land!
> All hate, most fear you, and few understand."—POPE.

But, be that as it may; what he has to propound is expressed in clear language, void of ambiguity, and as he supposes, with the force of any moral demonstration.

In our enquiries, we must review what we really do know relative to the subject under consideration, and thence deduce, as far as we rationally can, such conclusions as the premises may warrant. And as a preliminary, it is expedient to dispose of the commonly alleged causes of the tides, so far as they are within the writer's cognizance; and by seeing their incongruity with each other, and of their inadequacy to account for these phœnomena, to be convinced that we have still further to seek, before we can attain to a rational solution of the problem.

It used to be considered as a settled point, that the causes of the Spring Tides were, one of them, owing to the conjunction of the Sun and Moon, at the time of new moon; the joint force of the attraction of these two luminaries, then acting in concert upon the waters, as we say, beneath them. So far as this goes, all seems well, and unobjectionable; but, in the course of the month, we have two spring tides—one, as above, at the new moon; the other, at the full. Which was pretended to be accounted for—as also the cause of having high water twice in the twenty-four hours (a little more)—by saying, that as the waters were elevated by the joint attraction of the said luminaries, when in conjunction, on the part immediately beneath them; so, in the opposite hemisphere, at the distance of the Earth's diameter, the attraction of the luminaries could not there operate, the waters would bulge out from the level surface, and thus present an ellipsis, the extremes of the transverse diameter of which, would be the two lofty waves, which in a progress half round the earth, in the space of twelve hours, would, in succession, form the twice high water in the course of a day.

Now, only to think of these absurdities. To suppose the course of the waves to rush on and perform a journey of 180° in twelve hours, which is at the rate of 900 miles an hour; and this on the further supposition of there being no land or other intervening obstacle to intercept them; and it ought to be an answer to any such supposition, to say that it is purely gratuitous. But according to the present configuration of the earth, let us take what must be their course from the Antipodes, to the Land's end in Cornwall, in their usually but erroneously assigned direction, viz. from the east to the west. These Antipodes are somewhere about New Zealand. By girding a terrestrial globe with a string, in the direction of from New Zealand as aforesaid, to Cape Cornwall, it will be seen that there occurs first the obstruction of New Holland and the Indian Islands, surmounting which, there next occurs the obstruction of the whole of the south-eartern Coast of Africa; so that being obstructed in a direct course, the supposed wave must descend to the south-eastward, till it reaches the Cape of Good Hope, rounding which, it will then have to begin its ascent, to reach our Channel. So that at the least, upon this false supposition, as tested by the string, the waters will have to perform a course of first the half circumference of the Globe 180°, next the descent to the south-eastern Coast of Africa, of not less than 36°, and next the ascent from the Cape of Good Hope to our Channel, of not less than 121°. We have therefore the 180°+the 36°+the 121°, their sum 337°—equal to 20220 miles—which divided by 12, for the semidiurnal return of the tides, gives a required velocity of 1685 miles an hour, for that of the old theoretical, but erroneously supposed tidal wave. And the hearing of which, by Domine Sampson, he cried out, prodigious! as well he might!

By bringing the brazen meridian of the Globe to pass over the places mentioned, viz., New Zealand and Cape Cornwall, and regarding its eastern side, we shall see what we have already declared as the result of the examination by the string.

And then again, to think of this further absurdity, that of assigning the same effects to opposite causes: a spring tide to be produced by the joint action of the Sun and Moon, at the time of new moon, by the sum of the forces of their attraction; and another high water spring tide to the action of the full moon alone. But if this were the case, as the Sun and Moon are in opposition to each other at the full, and consequently the waters acted upon by only the difference of their attractive influence; if the sum of the attraction of the luminaries make a spring tide at the time of new moon;—it must be impossible that the difference of these influences can make another spring tide at the time of the full. And further, with regard to the two high tides in the course of a day, at the time of new moon—to say that one is due (as it is said) to the joint attraction of the luminaries; and the other, owing to the absence of any such attraction! That any such absurdities should have gained currency seems wonderful! It is to assign, *sine causa effectum*—an effect without a cause.

To help this matter out, there has been brought forward the hypothesis, that the cause of the changes which we observe in the tides is in part owing to the diurnal rotation of the Earth on its axis. This supposition is as great a fallacy as the other. So many thousands of years have now elapsed, since Noah's flood,—at least, when perhaps the Earth was remodelled,—that any motion by which the waters may be supposed to be affected by the Earth's rotation, has long since found its equilibrium, and will be a constant quantity; and can, therefore, by no means affect the alternate ebbing and flowing of the sea, or have anything to do with the cause of spring and neap tides.

Another Theory is, that the Earth has a seven-fold motion:—first, on her axis; secondly, in her orbit; a third, round the common centre of gravity of the Earth and Moon; the rest need not be mentioned; but touching this third motion, the Theory ascribes to it, in part, at least, the cause of the tides. But, supposing this motion to be real; any influence by which it may affect the waters of the ocean—as in the case of the supposed effects of the Earth's revolution on its axis—will long since have found its equalizing point, become a constant quantity, and therefore incapable of at all helping to solve the intricate problem under consideration.

What then remains? Though, perhaps, we may be unable entirely to clear up the mystery, in every particular; it may be allowable to proceed as far as we rationally can in the attempt: as the man who first, in a right direction, cut down a few trees in a forest, commenced the operation happily completed by his successors—of making a path through the trackless wild. Let us consider what we really know; and first, of that part of the Globe in which, as from a source, the tides may be said to be propagated.

By inspecting a Map of the World, or a Terrestrial Globe, it will be seen, that the Great World of Waters, is the Great South Sea, extending from about Japan or China, easterly, all the way to the western coast of America; and from Cape Horn, quite round the Globe;—while, in our hemisphere, the northern parts of America, of Greenland, of Europe, and of Asia, closely approximating; together with the eternally frozen Zone; for we have no faith in a Polar Bason; restrict the waters of these northern parts of the world to such narrow limits, as to be of no consideration in this discussion.

It is therefore chiefly to the world of waters—the Great South Sea—called the Pacific—that we are to look for the origin and maintenance of the Tides;—the Atlantic Ocean, and the East Indian Ocean, north of the Cape of Good Hope, though vast, being but subsidiary.

Next, let us consider the direction in which the volumes of waters influenced by the heavenly luminaries, must have their course. The Earth, in its progress through its orbit, passes from west to east; the same may be said of the Moon, in her orbit; and also of the revolution of the Earth, on its axis. All these are real motions, and in the same direction, videlicet, from west to east. It follows as a necessary consequence, that these motions being all from west to east, the attraction must be in the same direction, and the waters, in obedience to it, must also flow from west to east. This point we insist upon, and it cannot be otherwise, unless we affirm the absurdity of asserting their course to be contrary to the direction towards which they are attracted.

The Great South Sea, this vast receptacle, may be considered as extending from about the 130° of east longitude, to the 80° of west longitude; from about Borneo, to the Isthmus of Panama; and of the entire breadth of both Tropics. This space is in breadth more than 40°, in fact, we may well take it, including the waters on each side of the Tropics, at 80°, and in length, more than 150°,—for the few small Islands interspersed are of no consideration.

There was a time—"E'er flowing tides began," certainly!—in which tides were not. But when they began their course, it was by reason of the grand luminaries acting upon this vast expanse of water, (at least, with more power than upon lesser expansions,) and the direction being from west to east, their action would bring great undulations, and also an accompanying stream; to impinge upon the west coast of America, in the first instance, and mainly some where about the Equator. Being here resisted by the land, the waters may be expected chiefly to have accumulated, and then dividing into portions, one would set to the northward, where they would be obstructed; and the other, and greater portion, to the southward, towards Cape Horn, where the vacancy is the greatest, passing round which, towards the east, it would meet with another accumulation of waters, also setting easterly; and these waters, in this southern latitude, together with those coming down from the Equator, from the west of Cape Horn, would be so much higher than those of the South Atlantic, called also the Ethiopic Ocean, that they would fall down into it, and run to the northward; but influenced by the eastern tendency of the waters in the said South Atlantic, occasioned by the same *tractive* power which originated their motion; the greater part would run over and strike upon the south-west coast of Africa; tending, according to the configuration of the coast, to the northward. Another portion, after coming as described, from the southward, would run up parallel to the south-east coast of America, towards Brazil. But the waters which are thrown upon the African Coast, as above, would probably be deflected thence towards the Gulphs of Mexico and Honduras, which they would enter between the opposite Capes of Cuba and St. Antonio, on the one side, and of Yucatan and Cartouche, on the other; and the circuits of these Gulphs they would make, having their exit round Cape Florida, and tending along the America coast to the northward, much increased by the volume of waters in this direction, impelled by the constant action of the south-east trade winds, and thus constitute the Gulph stream; and holding on their course, visit the shores of Portugal and Spain, into the Bay of Biscay, up to our Channel, which they would enter, and passing through the Straits of Dover, some would run along the coast of Holland, as high as Jutland, on the east side of the North Sea, and as high as about Harwich, on the English side. Another portion would run up the Irish Channel, embracing both sides of Ireland to a certain height; other some would run over towards the north-east coast of America, till they meet with an insurmountable obstacle, as will be shewn, when they would, being repelled, set to the southward and form the flood on the north-west and north-east coast of Ireland, as low down as the Isle of Man, on the one side, and running down the North Sea, form the flood along the north-east coast of Scotland, and downwards as low as the coast of Essex, on the English side, and down the coast of Norway as low as the Skagerack, on the other; forming the flood at and along the places indicated; the Tides meeting near the Isle of Man, and also near the Galloper, and also near Dover.

But these north-about flood tides are, properly speaking, the ebb tides of the Atlantic Ocean; for considering the narrowness of the space between the North Cape to the eastward, and the American Continent to the westward, on the other, interrupted also by Greenland, and bounded to the northward by the eternal Ice; where is the body of water in this locality to form a proper flood tide? or where the power acting in opposition to the true known and recognized motive power of the luminaries, to set it in motion? The northern floods therefore depend on the same cause as the southern ebbs; the cause of which we shall presently explain. If these matters had been known and duly considered, the loss of many fine steam ships would have been prevented.

A great volume of this water, after coming from the south-west, would strike upon the Cape of Good Hope, running round which, some would tend to the northward, along the south-east coast of Africa, up to the Persian Gulph, on each side of Madagascar. Another, and the larger portion, would run over and strike upon the coast of Malabar, tending to the northward. Another portion would run round Cape Comorin and the Island of Ceylon, which was once joined to the main continent. Rounding this Cape and Island, some would run up parallel to the Coromandel shore, till it entered the Bay of Bengal; but the chief portion, still true to a north-east direction, would strike against the western side of the Peninsula of Malacca, and its rebound it is which occasions the great surf at Madras. Some would run up northerly, but the chief body of water would run through the Straits which separate Java and Sumattra from the main land, to which they were once conjoined. And round these Islands, towards the north-east, the same law would carry the tidal movement through the various Islands interspersed in the localities to which we have arrived, and so on, up by Cochin China, the south and east coasts of the Chinese Empire, and along the east coast of Asia, till its course being obstructed, it would again join the waters of the Pacific, and repeat its "mystic round." Such must have been the original course of the flood tide-making wave, and such, to a considerable extent, it must still continue, modified and controlled by the retrogressive ebb, which produces a vibratory or ossilatory motion of the waters—a series of progressions and recessions, as shall be further explained.

Before the Earth was properly consolidated by the attraction of cohesion, as now it is—when it had been but recently extricated from the bosom of the great abyss—when every thing which was not solid rock, and removed to a great distance from the shore—when the Earth, properly so called, must have been almost in a semi-fluid state;—it is easy to conceive how the action of the waters, in the manner and direction suggested, must necessarily have washed away vast portions of the shores along and against which their course was propelled, and imparted to each portion of the different Peninsulas which constitute the southern extremities of both Continents, that remarkable tongue-like appearance, in which they all agree; and which would be the more remarkable in the case of the southern Peninsula of America, and the Isthmus of Panama—as thereabouts the first and greatest shock of the waters would be received. And this supposition will account for the difficulty still experienced by Navigators in doubling Cape Horn from the eastward; they constantly meet with a current opposed to them;—it will also explain the reason of the danger of being embayed on the coast of Chili.

Next, as to the velocity of this constant stream of water,—which is a different thing from that of the tide-making wave. It is not necessary to suppose that any large portion of the waters of the Pacific actually find their way into the British Channel, though they impart a motion to the waters with which they are immediately in contact, and produce an effect as though they did. Though much water must necessarily be projected upon the coasts, the western coasts especially of all the above named Peninsulas, yet the chief part is reflected, driven back, by breaking on the shore in the frightful manner, in which we see, in those localities; and the residue, in its course occasions a superficial or easterly current, as we suppose, setting up both the Atlantic and Indian Oceans.* And although the motive power of the attraction is very swift—being equal to that of the Earth's diurnal rotation on its axis, at the least; yet having to act upon the inertia of the waters, their obedience to its solicitation may be comparatively but very slow. Thus, if a weight of five pounds were to move with the velocity of, say 20, its impetus would be equal to 100; but if the inertia were equal to or greater than this quantity, the application would be vain; and if the inertia were equal to 98, the motion communicated could be but 2. Thus, although the velocity of the moving power, in the case under consideration, be excessive—the inertia of the waters acted upon is also very great; and results shew that we cannot estimate the actual velocity of the current of the water, thus set in motion, (the current, as distinct from the tide compelling power) at above a mile an hour, on the open sea.

A Reverend Professor has published his ideas on the subject of the Tides, which are well received by his co-associates and co-mensales. He brings them round the Cape of Good Hope, up into our Channel, assigning them a velocity of 800 miles an hour; but who ever saw anything in the course of nature, or of philosophy, to bear out so extravagant a supposition?

How then does this attractive power issuing from the great luminaries, operate upon the waters? It operates by means of exciting in them undulations. We all know what these are—progressive ridges of water with valleys between. We often see and feel them exemplified. A poor ship is often beset by them in a calm, and is caused by them to roll from side to side so fearfully, as to excite apprehensions for her safety. This occurrence remarkably prevails and perplexes Mariners who may happen to get becalmed to the southward of the Islands in the Atlantic, especially the Canaries. It may be, and probably is, owing to the up-coming and equable undulation to which we ascribe the cause of the tides, meeting with the obstruction of these Islands, against the shores of which they break with fearful violence, and thence rebounding in a direction nearly opposite to that in which they advanced, meet again an up-coming undulation; the opposing concussions of which must make awful waves, whose agitation distresses the ship more than a heavy storm would have done.* Yet if an experiment of trying the current were then made, there will most likely be but little or none, and not at all in the direction which the set of the great waves might seem to indicate. Also we know what undulations are when occasioned by the sinking of a stone thrown into still water, or by the passage of a steam boat on a river.

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* Permit us to insist a little on this point, though at the risk of some tautology. The appearance of the heavenly bodies travelling over the Globe from east to west, is only an apparent, not a real motion. The Earth on her axis revolves from west to east, consequently *towards them*—their celestial magnet—which therefore influences the waters to advance from west to east towards them. But this advance meeting with the obstruction of the land, must form an accumulation which will run down the obstructing body till it finds a place of exit; through this passage it will run, forming a current which will take whatever direction may be impressed upon it. This direction, we have shewn, must be generally towards the north-east.

The accumulation of waters in the 56° of south latitude, coming from the westward, as has been shewn, having reached the meridian of and got to the eastward of Cape Horn, together with the waters accumulated on the western side of the Cape of Good Hope, form a vast collection, which will fall down upon the waters of the South Atlantic, to which they will be in an especial manner invited, by reason of the constant and forcible action of the south-eastern trade winds; which, by driving the waters on which they operate towards the Mexican Gulph, leave the level of the part thus acted upon below the level of the part to the southward, where they *act not;* the consequence of which is, that these southern waters rushing in, as has been said, continue in a northerly and north-easterly direction; the undulations begin in the Pacific, and which, as the cause is constant, though variable in quantity, the effects produced will also be constant, though variable in quantity. Of these undulations there will be many produced between their source and the chops of our Channel, into which falling they will be propagated easterly, till in the North Sea they meet with other undulations, coming, as we say, north-about, where they will be repelled and checked, and exceeding rapid and high tides will be the consequence.

Matters being as we have shewn they must necessarily be, every such undulation must occasion high water, at and over the spot to which its summit has reached; and its recurrence will be constant, because the power which excites it is constant. The phœnomena produced might have been different to what we see, if the producing power or the inertia had been differently constituted; but being as they are, the tides will be as they are:—videlicit, high water twice in about every 24¾ hours.

Please to bear in mind, that the subject here treated, is that of the general and universal cause of the Tides of the Ocean, and not at all of the cause of particular and local tides, which will depend upon local and peculiar circumstances.

It ought to seem, that as the New Moon is the cause of the spring tides, so the Full Moon must be the cause of the neaps. This at first appears to be a startling proposition;—and this difficulty interposes; we have two spring tides in the course of a month, and only one new moon. But if what has been proved be remembered,—viz. that if the attraction of the Moon, *plus* the attraction of the Sun, produce one high tide; the attraction of the Moon, *minus* the attraction of the Sun, can never produce another. It is impossible. It must *produce a neap:* let this be a settled point. How then can we attempt to solve the difficulty? Only by supposing that the undulation occasioned by the joint action of the luminaries is such as to extend every where twice in the course of a month, leaving an interval of a fortnight between each, just as one stone thrown into a pond will occasion several circles, with intervals of some seconds between each. And it follows, that any particular tide happening on any particular day, will not be owing to the particular phasis of the heavenly bodies on that day, but to their phasis many days preceding;—just as the blossoming of the rose, or other flower, is not due to the aspect of the heavenly bodies on the day of its expansion, but to a long course of previous preparation.

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* Prudent Mariners endeavour to avoid passing to the southward or westward of these Islands, at a nearer distance than that of 100 miles, at least, to avoid the distressing calms and turmoiled sea which so generally prevail under their lee side.

And it will follow as a necessary consequence, that in the same manner, and for the same reason, as the joint attraction of the Sun and Moon, at the time of new moon, produce the two spring tides in the course of a month, with an interval of a fortnight between each; so, by the same law, the difference between the attractions of these luminaries, at the time of full moon, will produce the *two neap tides* in the course of a month, with intervals also of a fortnight between each. Nothing seems more certainly established.

The Theory also runs thus. At the time of new moon, the joint attraction of the luminaries produces one stupendous undulum, which rushing onward leaves a vacuity behind it, into which the water from the rear rushes and makes another undulum, which follows the first at its limited interval of time and distance, in the same manner as we see in the case of undulations on a small scale, to which we have already adverted. And on the supposition of its being new moon on any given day of the month, suppose the fifteenth, the high water spring tide occasioned by that phasis, will not occur till the thirtieth, at the time of full moon, a fortnight afterwards; and the next high water spring, proceeding from the same new moon, not till the fifteenth day of the coming month, when it will be again new moon; and the phœnomena will be continued, and every intermediate tide will be governed by the same law, and be spring or neap, or intermediate, according as the attractions—the exciting cause—are united, or opposed, or intermediate.

This Theory being new, certainly appears curious; but nothing contradicts it; whereas every sound philosophical principle contradicts the *old theory*, and demonstrates it to be void of foundation, and its truth impossible.

Such, it is apprehended, must have been the manner in which the tide-making influences acted at first, and such the obedience rendered by the waters to their power; but which has subsequently become so modified as to assume a vibratory and oscillatory character, as will be explained at large in the progress of our work.

Our next inquiry regards the velocity of this tide-making undulum, the inquiry is difficult and curious, and our data not so satisfactory as might be wished, but not knowing any better to exist, we take the following.

From Scilly to Dungeness, is a distance of about 335 miles; and it is high water at Scilly at half-past 4, and at Dungeness at half-past 10, full and change, the interval six hours; which gives a velocity of nearly 56 miles an hour for the tide-making undulum. And appearances answer to this. For when it is high water at Scilly, it is low water at the Ness, and *vice versâ*. Admitting, however, that in particular narrow and tortuous channels, in which occur obstructions, from any cause, the rate will be different.

And as it is low water at Scilly when high water at the Ness—distance 335 miles—so, the same distance from Scilly, to the westward, it will also be high water; and thus, upon a straight course, there will be, simultaneously, high water at the distance of about every 700 miles asunder.

And concerning the distance, at which, from us, the motions may be supposed to originate. From Scilly to Cape Horn is a distance of 105° of latitude alone, we have taken 10° more on account of the supposed devious course, making 115°. We have a right to take other 56° for the southern passage of the waters, in their descent from the Equator to Cape Horn, while to the westward of the promontory; and as the beginning of the motion is supposed to be near the extreme eastern range of the Pacific—*i. e.* from the vicinity of the eastern shores of the Asiatic Continent, which from about Borneo to Panama, comprises 150°. Take 130° of this breadth, and as the waters, after coming round the Horn in their progress to the eastward, will not run up at right angles to a former course, take 30° for the sweep of their curvature—the ocean here is 70° wide;—these enumerations added together, make 105+10+56+30+130=331°=19860 miles.

And 15 days' interval, at two tides a day, give 30 undulations, which at the distance of 670 miles between each, are 670×30=20100 miles. Such an approximation to the above, as to be wonderful—almost fearful! And if we calculate in this manner,—in 15 days are 360 hours, which at a velocity of 56 miles an hour for the undulum, give a distance of 20160 miles: we can hardly devise for the Theory a stronger confirmation.

Let it be understood, that this rate of velocity for the undulations, or for the effect produced by them, is the rate at which the tide compelling power travels on the open sea; but the rate of the actual stream, as we have seen, can hardly exceed one mile an hour. Although, where there is a vast accumulation of water over a broad expanse, as in the Bay of Biscay, and also in the emboucheur of our own Channel, and many other places; wherever a narrow outlet is presented to these, we may say, pent up waters, (narrow as compared with the broad expanse in which it was with no great velocity accumulated,) through such outlet the tide will rush with almost the force of a cataract, as in the Garrone, the Adour, &c. and through the Straits of Dover: and where long resisted, when this resistence is overcome, it will form what is termed a Boar—a lofty rushing wave, which has been accumulated in deep water,—proceeding onwards till the water shoals, it then rises up, rushes forward, often with considerable elevation above the ordinary surface, and with great velocity fills up all the shoals to which the tide had not previously attained. These boars are common to all rivers, the beds of which agree with the above character. The boar is remarkable on the Severn; is found on the Humber, on the Shannon, and even on the Thames, as high up as Putney and Barnes. And in the Boca Draco, or Dragon's Mouth, at Trinidad, the current—I have seen it—sometimes runs at the rate of full ten miles an hour.*

Thus we have with great probability, and with a nearer approximation to the truth than was at the first expected, accounted for the flowing of the Sea. Now for the grand difficulty,—which it seems usual to overlook; and an attempt to explain which we have never yet been happy enough to meet with; viz. the cause of the retrocession of the waters. The usual theory will make the ebb pursue the same course as the flood. We have shewn "why swelling tides exalt the roaring main;" but to shew "into what dark caverns they retreat again."—

"Hic labor—hoc opus est." A hem! A hem! [illegible]

If we have up to this time been rather dogmatical—we hope it has not been offensively so; but now we intreat your candour—while, with bridle, or main sheet, in hand, as you please—and with great circumspection, we proceed in the research.

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* Old Trinculo, the Boatswain, one day hearing some of the young gentlemen discourse concerning Alexander's invasion of Persia, and of the disaster which befel his fleet at the mouth of the Indus, which one of them ascribed to a Boar: 'Aye,' said the old sailor, "serve the soldier lubbers right; howsomdever, it was nigh proving a d'm'd boar to them.'

It has been shewn how the undulation, originating in the vasty deep, the Great South Sea, is propagated round Cape Horn, in a north easterly direction, and falling into the South Atlantic, would impress upon its waters a similar, namely, an undulatory movement to the northward; and we have brought them up to the height of Scilly. But there is nothing in the way of obstacle presented to their still further progress to the northward,—for the British Isles, compared with the breadth of ocean, between the west coast of Ireland, and the north-east coast of America, are quite inconsiderable. The undulations will therefore proceed northerly, until they encounter the obstructions of Greenland and the Polar ice. Here must they be brought to a pause; further on in their long continued course they cannot go. Let us contemplate the position of the lofty, but impeded wave. Behind it, to the southward, is the Gulph, deep and broad, out of which it has risen. It cannot remain quiescent. Gravity presses it downwards; northward it cannot proceed; to the southward the passage is open; it sinks down, therefore, into the Gulph, and runs southerly till it meets an up-coming wave, to which it gives a check, as itself has been checked by the ice. This now mentioned wave must retrograde, and so each in succession, all the way down to Cape Horn; and still retrograding, round that promontory, in a direction opposite to that in which it advanced—the retrogression will proceed quite round the globe:—these retrogressions forming the ebb tide; as the progression of the wave formed the flood.

And in proportion as the wave was lofty, which formed the spring flood tide, so the Gulph was deep, out of which it was extracted; and on account of there being a greater depth to fill up, the returning waters will rush with so much the more impetuosity into it; and leave a greater extent of shoal, at low water, on the spring ebb.

But we have not as yet concluded our difficult enterprize, we have only "*scotched the snake, not killed it.*" We have described both the progressive and retrogressive wave, as pursuing their respective courses—undulatim—all the way round the Globe; it seems needful, as a preliminary, so to state it; but the matter is not so; for the down-coming wave, from the northward, meets the up-coming wave from the southward, at every six hours' interval, or thereabouts, and the strongest prevailing, the other is obliged to recede; till having acquired volume, as we may say, by falling back upon its resources; and the other being weakened by extending its line of operations, it is attacked in its turn, and in its turn repelled; and thus the attack and repulsion, so to speak, are eternally reciprocated:—the influence of the great luminaries being the exciting causes. But except a current, as we have shewn, always running to the eastward, the body of waters which form the tides are restricted to a space of about 670 or 700 miles—for each set of undulations; and in this space we suppose them to perform their eternally conflicting and alternating course. This on the open sea, clear of obstructions; insomuch that at every interval of about 700 miles, in the direction of the undulum, we may expect to find it simultaneously high water.

Let us endeavour to illustrate this dark problem a little further. At the Nore it is high water, full and change, at twelve o'clock, and at London Bridge at three o'clock. But the tide must have made upwards, at the Nore, six hours before it was there high water; also at London, the tide must have began to flow six hours before the hour of three o'clock, that is to say, it began to flow at London at nine. But it must have been running down till nine; so that, at eight it was strong ebb, while at the Nore it was strong flood. These opposing tides must meet some where, and make slack water; but the flood prevailing, will proceed up to its limits; and thus we see how two opposing tides co-exist—countervail, and alternately prevail over each other.

Jamque opus exegi!—A hem! but, hush! no more of that! no more of that. Davus, non Ovidus sum!—Yet it is hoped that the mystery has been pretty well cleared up.

And as a full confirmation of the theory, that the tide is propagated by means of undulations, and not by the actual progress of the stream; consider what has been said. From the beginning of the flood at the Nore, till high water at London, elapses a period of nine hours, but the tide no where exceeds four miles an hour—the average, three. But three miles an hour, for nine hours, give but 27 miles; not further than from the Nore to Gravesend; but by this time it has made high water at London, a distance of 50 miles. Whence it indubitably follows, that the actual stream of flood can never ascend from the Nore to the Metropolis. For the first of the flood, meeting the last of the ebb, checks it, drives it back, volume upon volume, in rapid succession, or rather, incessantly, causing its constant accumulation, till it reaches its maximum or high water mark; it then begins to retrograde, but with still greater rapidity than that in which it advanced. Also from the Islands of Scilly to Dungeness, is a distance of about 335 miles, as has been said, and the times of high water are respectively half-past four, and half-past ten, or from the first making of the flood at Scilly, 6 hours more, giving 12 hours for the continuance of the flood, till it reaches Dungeness; meanwhile, in mid-channel, the tide's velocity never exceeds at any time 4 miles an hour. Three miles is a large average. But 3 miles an hour, for 12 hours, is 36 miles, which is about the distance to the Lizard only; meanwhile, the undulations, at about 56 miles an hour, have made their way up to Dungeness, and there produced high water.

The reason why the undulations are propagated with greater velocity in the Channel than in the River, may be occasioned by the many sinuosities and tortuous windings, and shoal places, with which it abounds, as well as to no inconsiderable body of the fresh water, the proper water of the River, which has to be repelled; but chiefly to the first cause we are to ascribe the difference.

And if anything more, in confirmation of this Theory be wanted, it will be found in what is experienced on the North Coast of Spain, and probably in many other places. When there happens to be a great sea breaking on the shore, though the distant cause may be unknown, the waters in the various harbours are affected by, what is called, a range. The ships in the harbours are, almost suddenly, so elevated by an influx of water, without any increase of the current, as to pluck up their anchors and break adrift from their moorings, and in a little time afterwards they will perhaps be with their keels striking against the bottom, and this several times repeated in the course of an hour; all the while the tide, properly so called, both flood and ebb, will run with a gentle and equable stream, and not be at all affected by the above stated phœnomena, the weather moderate, and the wind blowing off shore.

The practical lesson derivable from this Theory is—to caution Navigators, that in coming across the Atlantic, from the southward and westward, towards this country, as also in going round the Cape of Good Hope, whether towards India or to New Holland, they ought to be prepared to find the ship ahead of her reckoning, and to be on their guard accordingly; and in pursuing a course round Cape Horn, to the northward or westward, to expect a contrary result, and to consider that a ship steering a course, at a rate of 6 miles an hour, should she encounter an unknown current setting broad upon either bow, at only one-third of that rate, it will give her a diminished rate of velocity of one mile an hour, and cause her course to be one point and a half different from that on which by the compass she is supposed to be steering.

Hence, under Providence, which so generally befriends 'the wanderers o'er the deep,' the old remark of the paramount utility of the three L.'s, viz. Latitude (when obtainable), Lead, and Look-out,* should be in constant requisition when a ship approaches the land; and in actual value, as to a ship's security, they are far beyond all the chronometers that ever were made. These may and do conduce to the mariners' ease on the open sea; but in thick stormy weather, with the land to leeward, no prudent man will venture to approach, by a great deal, the shore, trusting to them. Scarcely Providence itself, with reverence be it spoken, can or will protect such as, uncompelled, rush upon a lee shore, supposed to be at no very considerable distance, in thick stormy weather; unhappily, we have but too many fatal instances occurring of such infatuated recklessness on the part of men from whom we might have expected better.†

A great desideratum at present, but which might with no difficulty be supplied, is, that the Lords Commissioners of the Admiralty should appoint vessels to make observations on such parts of the Coasts of these Islands as the matter to be enquired into demanded, (because unknown) relative to the strength, duration, height, and set of the tides, and especially how long they continued to run after high water, in the offing. These vessels, in summer time, when alone the observations can be made, should be brought to anchor at a moderate distance, 8 or 10 miles from each of the remarkable head lands on the Coasts, and remain at an anchor at each station during 2 or 3 days, so that the matter in question may be thoroughly ascertained. The same observations to be made in the different Bays with which our shores are indented; and the result being properly tabulated, should be published for the benefit of our Coasting Navigation. There is a well known formula by which the time of high water being found any where, on any day, it may be reduced to the time on the full and change days.

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* It is deeply to be lamented that hardly any consideration can induce the generality of Sailors to maintain a vigilant and long continued look-out.

† A terrible and fatal exemplification of the propriety of this remark has lately occurred in the loss of a large ship full of Emigrants, all of whom, as well as nearly all the Crew, perished at Basses Straits, New Holland. This catastrophe happened from the ship being a-head of her reckoning, and the master running, in consequence, down upon the land, till too near it, in thick stormy weather.

And a still more recent instance of destruction, through carelessness, ignorance, and rash presumption, has occurred in the loss of the late Tweed Royal Mail Steamer, thrown away upon the Alacranes Reefs, in the Gulph of Mexico, going at the rate of 12 miles an hour, in a dark stormy night; giving the unhappy passengers three minutes of terror and alarm, in which to prepare for eternity. Proceeding also from an unknown latitude, steering an unknown course, through a powerful but uncertain current; but in the known proximity of a horrid danger, without any necessity compelling: and all this in soundings where a cast of the lead would have indicated the vessel's position, and warned of the danger.

The ship was safe at sun-down, and for several hours afterwards. If then her Commander had steamed too (lay too) softly, with her head to the north-east, till daylight, all danger had been avoided. He ought to be held criminally responsible.

There was also on board, a Queen's Officer, charged with care of the mails. Naval Officers ought not to forget that they are nautical men, though not in charge of the vessel. As such they ought to keep the ship's way; and when they may happen to see a well marked instance of such rash ignorant presumption, as occurred in the case of the Commander of the Tweed, they ought to assume authority, pro hoc vice, and put him under an arrest, and save the ship and all the lives on board of her.

And as to latitude—besides the usually known methods for finding it—where the variation is exactly known, this method will give the latitude. Take an amplitude either at sun rising or setting,—that is to say, take his magnetic bearings exactly,—to this apply the variation, will give the true amplitude.—Then

As the sine of the true amplitude
Is to Radius,
So is the sine of the declination
To the co-sine of the latitude.

This formula is a conversition of the rule for working an amplitude.

There is a rule in Spherics, by which an altitude taken at any time of the day, and the time being known, the latitude may be thence deduced. Not the rule delivered in Hamilton Moor. It would be invaluable service in whoever would bring the rule to the level of ordinary capacities.

As to what are called rollers, great breaking waves rushing onwards, frequently troublesome and dangerous both to ships and boats, their cause may be ascribed to some distant storm raising a great sea, and directing it towards the shore, perhaps over an expanse of a thousand miles of ocean, and arriving near the land, there is not sufficient water for the deep wave to continue, without interruption, its onward course, it therefore rises and breaks frightfully, even in what might ordinarily be called middling deep water, and fine weather. It is a great and violent mistake in supposed men of science, but landloupers, to affirm that at the depth of 8 or 10 feet beneath the ordinary level surface of the sea, the water is always quiescent. I have seen it break near Fontarabia in 10 fathoms of water, during fine weather, being then out in a boat on duty; the depth of the wave therefore could not have been less than 66 feet, but within 2 or three miles the water was 70 or 80 fathoms deep; and the great waves setting in from the Western Ocean, had not, in a depth of 10 fathoms, sufficient room to roll on without impediment; they consequently, under such circumstances, rise and form breakers. The race of Portland appears to partake of this character.

If it be enquired, what are the reasons on which the conclusion is founded, that the tides are influenced *at all* by the Moon and her changes? They are the following. Where there are two bodies, and a change in the appearance and motion of the one, is always and invariably accompanied by a change in the motion and appearance of the other; it must be either that the change observable in one of these, occasions the change in the other; or that both of them are affected, and the changes produced in each, are ascribable to some third body causing these changes. Now we know of no third body, except the Sun, whose appearance being constant and invariable, his influence, whatever it is, will also be invariable; and to suppose that the tides can produce the changes in the Moon is ridiculous: therefore, the Moon and her changes of position with regard to the Sun, is the cause which produce the alteration in the tides.

The sum of our observations are these. The cause of the tide is the varied and variable action of the Sun and Moon, affecting the waters with different degrees of power; at one time, by the united force of their attractions, producing spring tides; and at another time, by the diminished power resulting from the 'difference of' their attractions, producing neap tides. That both the spring tides of a month are occasioned by the one new moon of that month, and both the neap tides of the same month, by the one full moon of that month. That the great source of accumulation of waters, from whence the movement proceeds, is the great South Sea, or rather, the great Western Pacific Ocean. That the motion, began in this vast receptacle, was originally propagated from south-west to north-east, all round the Globe; but has since become modified and resolved into a vibratory or undulatory movement, in the same direction. That these undulations, or propulsive and retrogressive movements,—similar to the pulsations of the heart,—have each a certain limit, at each extreme of which it will be simultaneously high water. That between Cape Horn and our Channel, there may be about ten of such undulæ, or simultaneously high water stations, their distance asunder being about 700 miles. That within this limit, the conflicting waters, so to speak, perform their vibratory or oscillatory movements; and that there is no rush of waters from the Cape of Good Hope to our Channel, still less from any meridian to its opposite at 180° distance. That every place over which the summit of any undulum passes, has then and there high water; that the velocity with which this tide-making undulum travels, is in our Channel, as has been shewn, about 56 miles an hour; in the Ocean, where it is unconfined, it will be more; it will be about 60 miles an hour, subject to be affected by storms and other causes. And that besides this vibratory tide-making movement, there may still be expected to prevail, a drain of current from the south-west to the north-east, and which to ships homeward bound, will be liable to make them ahead of their reckoning; and the same observation will apply to ships in the Indian Ocean, when proceeding easterly, of which danger mariners should be aware; and above all things, never, upon any confidence placed upon any chronometer, venture to approach a lee shore in thick stormy weather, when an observation for the latitude has not recently been had, and the ship's position at all dubious; and in the case of ships coming from the Ocean in such weather, and under such circumstances, not even to endeavour to enter our Channel nearer than by a supposed distance of 200 miles at the nearest. The ship should be made as snug as possible, and be prepared for the worst, and under as little sail as will enable her to steer, endeavour to hold her own, sounding very frequently, and wearing as may be deemed expedient; and so continue till either the weather clears up, or the ship's position be clearly ascertained, remembering that in a hard gale, lying too, a ship's drift will be at least 60 miles in 24 hours; and in Navigation generally, to be aware that into every bay, or estuary, every where, there is a strong indraught of a tide or current to be guarded against.

After all, however correct any theory may be on any subject, unless it leads to some practically useful result, its value will be but small, except as an object of curious speculation; and such will be remarkably the case with regard to a Theory of the Tides, which, unless it assists us in avoiding some of their inconveniences, and of availing ourselves of their advantages, is worth nothing. It is hoped this Theory may be useful in both these respects.

Jamque, lector benevole! Vale!
Si bene factum sit,
Plaudito!
Si non
In manibus tuis sum et arbitrio tuo.

APPENDIX.

The candid reader of the preceding pages, will have been put into full possession of this New Theory of the Tides; and will perceive the chain of argument by which it is established, and which it is necessary to exhibit in order to remove all doubts to which a mere annunciation of the theory would be liable; and he will be enabled to perceive the delusions into which men of science run, when seeking after the theory of the tides by exact barometrical or thermometrical—or other *etrical*—observations; or by nice calculations of the Moon's altitude, corrected for parallax; or for painful and tedious observations as to the rise of the tides at different naval stations,—for, on account of the influence of winds, and other causes, they never can possess real accuracy; and if they did, they would still be useless. And the same may be said of magnetic researches on this subject. Researches such as the above, for such a purpose, denote only the pruriency and nugacity of the attempts.

But as many will be attached to preconceived opinions, and as some part of the arguments used in the tract may not be sufficiently clear to every apprehension; and all have a right to have the fullest evidence submitted to them; we proceed to exhibit a series of calculations, beginning at the Cape of Good Hope, and repeated as high up the African coast as Mogadore; also of calculations on the tides at stations in the Atlantic Ocean—from Bona Vista to Terceria, and from Terceria to the Channel; and the results of these calculations, founded on this theory, will surprise by their near approximation to authoritative statements; which is such as to amount to even an arithmetical demonstration, of at least, that the theory is conceived with care, and is borne out by facts. And it is humbly offered for consideration, that the data on which the calculation proceeds, is not suppositious. That the scale by which the calculation is conducted, is actually that furnished by the distance and times of high water, at Scilly and Dungeness respectively, only a little extended as the theory allows, of from 56 to 60 miles an hour for the tidal velocity, on the unconfined ocean, and on the African coast; and of twelve times that sum, or 720 miles, being, for the same reason, on the unconfined ocean, taken as the space, at each extreme of which, it is affirmed, will be found, simultaneously, high or low water, or any other condition of the tides; and with a declaration which may be easily admitted; that the author did not fabricate the latitudes and longitudes of places, which for the most part are taken out of Hamilton Moor; nor yet the stated times of high water, which are taken out of the African Pilot, published by Laurie and Whittle, in 1799.

The proof of the Theory begins by an examination of what may be the expected time of high water at the River Cameroons. When the time of high water, full and change, at the Cape of Good Hope is 2 ho. 30′,—remembering that the lapse of twelve hours reproduces the same denomination of tide. The proposition therefore is, that on any day, say Sunday the 1st of June, it is high water at the Cape at half-past two; and the question is, at what time is it high water, on the same day, at the River Cameroons?

THE SOLUTION.

And by no other Theory than this, can the problem be solved.

	Lat.	M. P.	Long.	H. W.	
Cape of Good Hope	34° 29′ S. ..	2207 ..	18° 29′ E. ..	2	30
River Cameroons ..	3° 20′ N. ..	200 ..	10° 0′ E. ..	6	0
Diff. lat.	37° 49′	2407	8° 29′		

This diff. lat. 2269, the merid. do. 2407, and diff. long. 509 miles, gives a course N. 23° W. and a dist. 3096 miles. This distance of 3096 miles, divided by 720, the number of miles which separates the various stations at which synchronously high water obtains, gives four such stations, and a remaining distance of 216 miles; which, by proportion, gives 3 ho. 36′, for the time the undulum has been travelling to the next station. This time, added to the time of high water at the Cape, 2 ho. 30′, gives 5 ho. 56′ for the time of high water at the River Cameroons. The time indicated in the Pilot, being 6 ho. 0′. A coincidence so very near, as to be quite astonishing.

AGAIN.

It is high water at Senegal, lat. 13° 51′ N. long. 16° 9′ W. on a certain day, at 10 ho. 30′. Required, the expected time of high water at Mogadore, lat. 31° 25′ N. long. 9° 25′ W. The proper diff. of lat. between these places is 934 miles, the merid. do. 1024, and the diff. of long. 404 miles. This gives a course of N. 22° E. dist. 1004 miles. This divided by 720, gives one station, and 284 miles over. This turned into time, by proportion, gives 4 ho. 44′, which, added to the time of high water at Senegal, gives for the time at Mogadore, 3 ho. 44′. Differing but one minute from that indicated by the Pilot, which has for time of high water at Mogadore, 3 ho. 45′.

NEXT.

At Bona Vista, lat. 16° 6′ N. long. 22° 31′ W. it is high water on a certain day at half-past twelve, or 12 ho. 30′. Required, the expected time of high water at Terceria, lat. 38° 54′ N. long. 28° 15′ W. The Pilot states it to be at three quarters past eleven, or 11 ho. 45′. The proper diff. of lat. between these places, 1368 miles, merid. do. 1558. and diff. of long. 334 miles, gives a course of N. 12° W., dist. 1400 miles. This distance between the above named Islands indicates one station for synchronous high water, and 680 miles over. These turned into time, at 60′ to an hour, give 11 ho. 20′, which, added to the time at Bona Vista, 12 ho. 30′, give for Terceria 23 ho. 50′; which is equivalent to 11 ho. 50′. Differing from the time in the Pilot by only five minutes.

And this last example shews the reality of synchronous high waters on the open sea: for, at Bona Vista, it is high water at 12 ho. 30′, and at Terceria, at 11 ho. 45′.

LASTLY.

Let it be required to estimate the time of high water at Scilly, in lat. 50° N. long. 6° 42′, the data being Terceria, lat. 38° 54′, long. 28° 15′ W.; time of high water at this place, 11 ho. 45′, on Sunday, March 1st, or any other day, on the full or change.

The proper difference of latitude between these places, is 666 miles, merid. do. 937, and difference of longitude 1332 miles; which gives a course of N. 55° E.; but as our Theory supposes the course of the flood to be from S. W. to N. E., if we take the medium between these courses, viz N. 50°.: this from the same parallel as Terceria, gives, with the proper diff. of lat. 666°, a distance of 1038 miles; which gives one synchronical station, and 318 miles=5 ho. 18′ over. This time, added to the time of high water at Terceria, 11 ho. 45′, gives 17 ho. 3′, which is 5 ho. 3′. Differing from the tabulated time at Scilly only 18 minutes!

It seems useless to seek for any further proof of the correctness of our Theory, which appears to be entirely established; and which not even a difference from some local observations can shake, unless we were able to know that these differences were not attributable to local causes. Take, however, one more confirmation.

Given—Senegal, in lat. 15° 51′ N. long. 10° W., with its time of high water at full or change, 10 ho. 39′; thence to calculate the time of high water on the same day at Cape Blanco, in lat. 20° 41′ N. long. 16° 52′ W. The proper difference of latitude between these places is 290 miles, the merid. do. 306, and difference of long. 52 miles. These give a course of N. 10° W. dist. 294 miles; which, divided by 60 miles an hour, give 4 ho. 50′. This added to the time at Senegal, 10 ho. 30′, makes 15 ho. 20′; which is 3 ho. 20′ for high water at Cape Blanco. The African Pilot states it to be 3 ho. 45′. Differing from the book but 25 minutes. More examples would be worse than superfluous.

There seems to be little remaining to clear up. The only outstanding difficulty being to get rid of the waters brought into the oceans from round Cape Horn, and which we suppose to form the north-east current. It is suggested that they may find their way back, after the manner of what we call an under tow, or under current; as we see the clouds in the upper regions of the atmosphere often have a direction quite opposite to those in the lower stratum,—occasioned by opposite currents of air traversing the etherial space; and as the indraught through the Straits of Gibraltar is found to be accompanied by a deep under current, setting into the Atlantic. This supposition will carry the said waters to the southward, till having got below the Cape of Good Hope, they will unite with those running to the eastward in that parallel, and proceed with them towards India; some to the southward of the Molucca Islands, and proceed towards New Holland, rounding which and Van Diemen's Land, they will once more fall into the embraces of their mother—the Great South Sea.

The common theory brings all the waters of the Southern Oceans into our latitude, without returning so much as a drop.

And as touching the comparative influence of the Sun and Moon, in producing the tides; if we take the rise of the high water springs to be double the rise of the high water neaps, the respective influences with regard to the matter under consideration, will appear to be to each other in the proportion of one to three, namely, the power of the Sun in this particular, only one-third that of the Moon; for let the power of the latter be as 3, and of the former as 1, their sum will be 4, which may express the height of the high water spring; and from the power of the Moon 3, deduct the power of the sun 1, the remainder will be 2, the height of the high water neaps, as observations attest.

And although in compliance with custom, and out of deference to men of superior attainments, it is granted in this essay, that the attractive power of the Moon on the waters is greater than that of the Sun, though whichsoever of them really exerts the most power, will make no difference in the result; yet the Author has a strong opinion, that in the instance under consideration, as in every other, the influence of the Sun is the strongest: for these reasons. We are taught that the power of attraction increases directly as the mass, and diminishes inversely as the square of the distances; but the mass of the Sun is much more than forty million times greater than that of the Moon, so that at equal distances, the excess of solar influence would so many times preponderate; but the distance of the Moon is less than 240,000 miles from the Earth; while that of the Sun is more than ninety-five million; and if we make a proportion, and say, as the square of 240,000 is to 40,000,000, so is the square of ninety-five million inversely taken—that is to say, the forty million multiplied by the first term and divided by the third—the result will be a very excessive degree of preponderance, by which the influence of the Sun will exceed that of the lesser luminary. This observation is respectfully offered to such as possess more information in the matter than the Author, who is willing to be instructed; as to any consideration arising from the different densities of these bodies, he doubts whether our knowledge in this particular, be anything more than conjecture.

The above calculation may by Logarithms be very pleasantly and easily investigated.

Sit nomen Domine benedictum.
Amen.

FINIS.

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